Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

1.96
Ad6Tp

C4+/S4n

Erosion

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON 25, D. C.

In cooperation with the
Agricultural Experiment Stations
of
Indiana, Ohio, Iowa and Missouri

CROP YIELDS LOWERED BY EROSION

By
R. E. Uhland, Research Specialist
and Liaison Officer, Research-Operations

SCS-TP-75
February 1949

Many measurements have been made at soil and water conservation experiment stations throughout the United States of soil and water losses that accompany different systems of cropping and cultural operations. These measurements reflected the very rapid rate of soil destruction and high runoff under these different systems. It was obvious, however, in evaluating the effectiveness and practical application of soil and water conservation practices for a field or a farm that consideration must be given to crop yields and determination made as to whether the land is being used wisely, and if the permanency of the soil can be assured.

The data presented herein show that crop yields decline steadily as the depth of topsoil is reduced by erosion. Since soil and water conservation practices can be expected to compensate but partially for the loss of topsoil and organic matter that occurs under non-conservation farming, emphasis must be placed on the urgent need for the adoption of a conservation type of farming while a good amount of topsoil and organic matter remain.

Farmers who have selected their crops wisely and who have been careful in planning their cultural operations find more topsoil remaining on their fields than on their neighbors' fields which have been managed with less care. These same farmers who have managed their land so as to retain most of the original topsoil have, and will continue to have, much higher crop yields. The study shows that crop yields begin to decline with the loss of the first inch of topsoil. This will be news to those who feel that erosion does not affect yields until the subsoil is exposed.

CONTENTS

Page

Introduction 1

Procedure 2

Yields on Shelby and Grundy soils near Bethany, Mo. 4

Yields on Brookston, Parr, Fowler, Crosby, and Miami silt loam soils near Fowler, Ind. 8

Yields on the Marsnall, Shelby, and Tama silt loam soils for two areas in Iowa and on the Keene, Muskingum, and Coshocton silt loam soils in Ohio. 9

Results are in line with data reported for other areas and findings of State agricultural experiment stations 16

What farmers say about conservation and yields 26

Conservation farming must be adapted to meet the needs of the individual farm and farmer 26

TABLES

Table

1.--Corn yields from different depths of topsoil on four fields at Bethany, Mo., 1939 6

2.--Corn yields from different depths of topsoil on seven fields at Bethany, Mo., 1940 6

3.--Yield of corn for different slopes and depths of topsoil and the percentage of maximum yield produced by each depth class, Bethany, Mo., 1940 7

4.--Percentage of nitrogen contained in soil profiles, by 3-inch layers taken from four fields of Shelby silt loam at Bethany, Mo., under different types of management 10

5.--Calculated weight of nitrogen per acre in soil profiles by 3-inch layers for fields shown in table 4 10

6.--Corn yields from different depths of topsoil on 16 fields near Fowler, Ind., 1939 11

7.--Corn yields from different depths of topsoil on 18 fields at Fowler, Ind., 1940 11

8.--Corn yields for different depths of topsoil for three soil types at Fowler, Ind., 1939 11

9.--Average yield of corn from different soil depths on 16 fields at Fowler, Ind., 1939 12

10.--Corn yields from different depths of topsoil together with the percent organic matter in the plow depth (0 to 7 inches), Fowler, Ind., 1940. 13

11.--Corn yields from different depths of topsoil on 10 fields at Shenandoah, Iowa, 1939 17

12.--Corn yields from different depths of topsoil for two soil types at Greenfield, Iowa, 1938 17

TABLES (Cont'd)

Table Page
13.--Corn yields from different depths of topsoil on three watersheds at Coshocton, Ohio, 1941 . . . 18

14.--Influence of depth of topsoil on crop yields on a number of New Jersey farms . 18

15.--Corn yields (bushels per acre) by years for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45) . . . 20

16.--Wheat yields (bushels per acre), by years for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45) . . . 21

17.--Oat yields (bushels per acre) by years for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45) . . . 22

18.--Hay yields (tons per acre) by years for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45) . . . 23

19.--Data on soil renewal plots at Bethany, Mo., Soil and Water Experiment Station . 24

FIGURES

Figure
1.--This cornfield is being farmed up and down the slope. A single rain may remove an inch or more of soil from critical portions of a field and deposit some of it on more fertile areas further down the slope . . . 3

2.--Contour farming is a simple but very practical soil conservation practice which pays high dividends by holding the soil and water thus assuring higher yields . 3

3.--Relationship of depth of topsoil and yield of corn, and the percent of organic matter in the plow depth or top 7 inches. Data from 19 fields, Fowler, Ind., 1940 . . . 14

4.--Relationship between organic matter contained in the 0- to 20-inch layer of soil and corn yield, and association of corn yield with depth of topsoil. Data from 19 fields, Fowler, Ind., 1940 . . . 15

5.--Good crop rotations supported by terracing and contouring insure the conservation of the soil on this farm . . . 27

6.--Rotated contour strips supported by broad grassed waterways are proving effective in conserving soil and water on this dairy farm . . . 27

CROP YIELDS LOWERED BY EROSION

By R. E. Uhland, Research Specialist and Liaison Officer, Research-Operations, Soil Conservation Service

INTRODUCTION

Amazing as it is, there are still a few who question the fact that crop yields are lowered by soil erosion. However, these are theorists who refuse to weigh the facts. Farmers all over the country recognize that crop yields have been reduced because of the loss of topsoil. This paper presents data from different parts of the United States that show crop yields are directly proportional to the depth of topsoil.

The future prosperity and welfare of this country is dependent upon our ability to produce food--which comes from the soil. Therefore our future begins and rests on the sustained productivity of our agricultural lands. Records show that we have around 460 million acres of good cropland in the United States. This includes, besides that now in crops, about 70 million acres that need clearing, drainage, irrigation, or other improvements. About 80 percent of these 460 million acres is subject to erosion if it is not protected.

Data on soil and water losses secured at soil and water conservation experiment stations in various sections of the United States show that soil erosion is greatly accelerated by the growing of clean-tilled crops. For example, at Bethany, Mo., the average soil loss on a 7-percent slope, 72.5 feet long, cropped annually to corn, was at the rate of an inch of topsoil in less than 3 years. At Zanesville, Ohio, and LaCrosse, Wis., on somewhat steeper slopes the losses were even greater.

It is obvious that in evaluating the effectiveness and practical application of soil and water conservation practices for a field or a farm, consideration must be given to crop yields and determinations made as to whether the land is being used wisely, and if the permanency of the soil can be assured. General observations have been made at our soil and water conservation experiment stations and also on farms in every section of the country. These observations all show that crop yields on badly eroded fields and farms have declined sharply.

Factual data were secured in 1939-41 on the relationship between corn yields and depth of topsoil on field studies which were carried out by the Soil Conservation Service in cooperation with the State Experiment Stations of Indiana, Ohio, Iowa, and Missouri. These field studies were designed to give us a measure of the soil that had been removed from fields representing different slope classes with respect to degree and length, and also tell us how these losses had been affected by the way the land had been used since it was first brought under cultivation. In addition, the studies allowed us to determine what effect soil removal from different soil types had had on the productivity of the land as reflected in the per-acre yields of corn. If, for instance, it were found that different degrees of erosion as represented by various depths of surface soil are portrayed by different crop yields, then it would be necessary only to evaluate a soil conservation practice or program in terms of time to erode an inch of surface soil in order to be able to predict the degree of permanency of the soil and the rate of modification or change of crop yields.

The data show that at all locations erosion has greatly reduced the amount of topsoil in all fields. The extent of the reduction of topsoil has been regulated by the type of management that has been used on each field. Soil and water conservation practices were shown to check the process of erosion and bring about immediate and continuing increases in corn yields. One of the major causes for the differences in the amount of topsoil is well illustrated by **figures** 1 and 2, page 3.

Findings reported by Murray[1] and Simondson[2] indicate that the corn yield on soils in southern Iowa increased with depth up to a point where the depth of topsoil was in excess of 8 inches. Studies reported by the writer[3] show that differences in corn yield within the same field were closely associated with the depth of topsoil. The yields were highest where the topsoil was deepest and lowest where the topsoil was shallowest.

The data presented herein substantiate earlier findings published in similar form and show further that for the associated soil types considered in this study little difference was recorded in corn yields for the same depth classes. In other words, much greater variations were found in the production for different depth classes of a single soil type than between different soil types with the same depth of topsoil.

The data at Bethany, Mo., for the Shelby and Grundy silt loams, at Greenfield, Iowa, for the Tama and Shelby silt loams, and at Fowler, Ind., for three associated soil types, showed much wider differences in yield for varying soil depths for the same soil type than between soil types. The findings for the Marshall and Shelby soils at Shenandoah, Iowa, indicated differences between soil types but the relationship between depth of topsoil and yield still held.

The findings show that erosion was checked even on those fields where soil conservation measures had been applied only within the last few years. The depth of topsoil remaining 5 years after conservation measures were first applied was 1.8 inches deeper than on a similar field that had no change in management. Both fields had been managed in the same way prior to 1935.

PROCEDURE

Fields of 10 acres or more were selected on which a complete record of past cropping and management was obtainable. These fields were cropped by farmers as a part of their regular farming operation. In order that the soil-depth readings might be analyzed with respect to physical characteristics such as the length and degree of slope, plane-table maps were made of each field and contours were mapped about 50 feet apart.

Most of the soils included in this study were developed under Prairie conditions and therefore have exceptionally dark surface soils. The topsoils in the main are silt loams and easily distinguished from the subsoils, which are finer in texture, more compact, and much lighter in color.

Since the plowing of these virgin fields and the growing of cultivated crops, particularly clean-tilled crops the topsoil has been removed from the land surface much faster than it could be built up from beneath. As soon as the topsoil becomes shallower than

---

[1] MURRAY, W. G., ENGLEHORN, A. J., and GRIFFIN, R. A. Yield Tests and Land Evaluation. Ia. Agr. Exp. Sta. Res. Bul. 252. 1939.

[2] SIMONDSON, R. W., and ENGLEHORN, A. J. Method of Estimating Productive Capacities of Soil. Soil Sci. Soc. Amer. Proc. 3: 247-251. 1939.

[3] UHLAND, R. E. Field Method for Evaluating Effects of Physical Factors and Farm Management Practices on Soil Erosion and Crop Yields. Reported in Soil Sc. Soc. Amer. Proc. 5: 372-376. 1940.

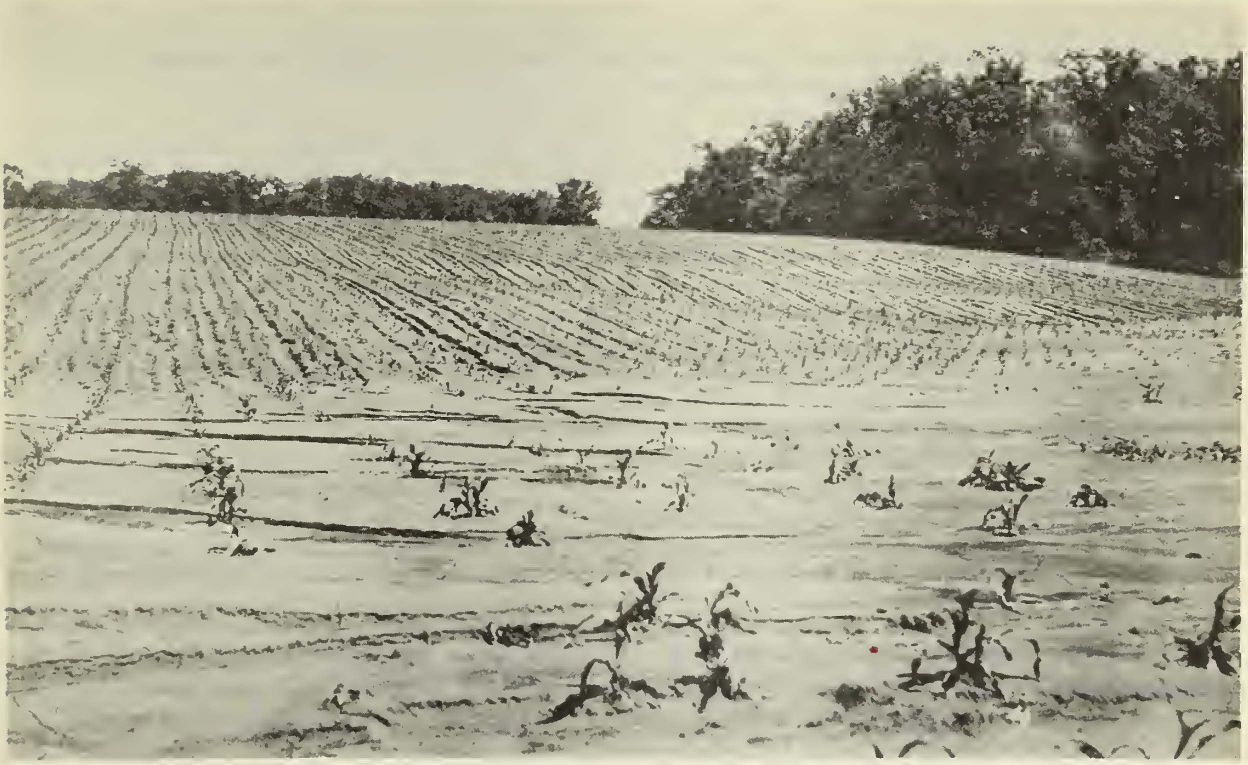

FIGURE 1.--This cornfield is being farmed up and down the slope. A single rain may remove an inch or more of soil from critical portions of a field and deposit some of it on more fertile areas further down the slope

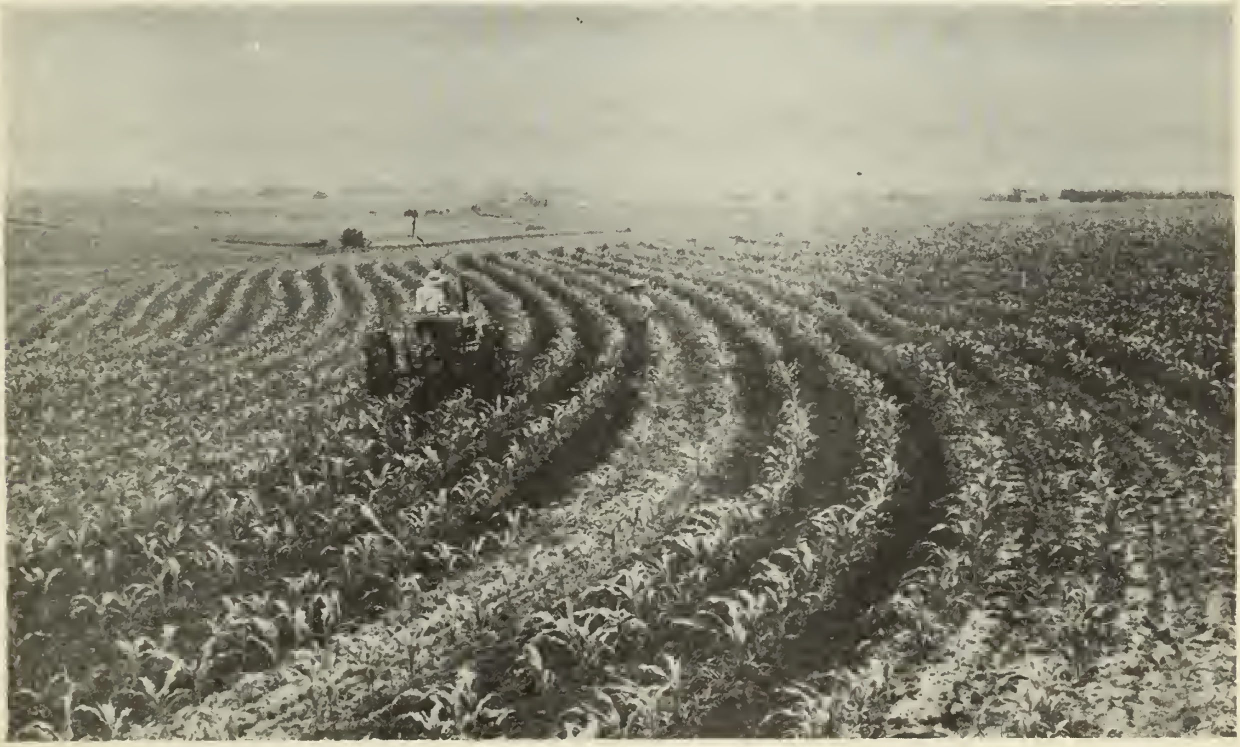

FIGURE 2.--Contour farming is a simple but very practical soil conservation practice which pays high dividends by holding the soil and water, thus assuring higher yields.

the plow depth it is mixed and diluted with the subsoil. This causes the surface soil to take on a lighter color and a heavier texture.

All topsoil measurements were recorded to the nearest inch. In the analysis of the data most of the depths are grouped into soil depth classes of 2 inches each. In order to have a check on the accuracy with which soil technicians were able to measure the depth of topsoil, samples of the top 7 inches were taken for analysis of organic matter. These samples were so distributed that every soil depth class was represented by 4 to 6 locations within the field. Four hills of checked corn were harvested at intervals of 50 feet over the field. Where the corn was drilled, 2 adjacent rows, each exactly 8 feet long, were harvested instead of 4 hills. Since the corn was harvested and yields recorded in the fall after the contour map was made in the spring, soil-depth readings were taken again at the same locations as the corn yields. Moisture determinations were made on corn samples for each field and needed adjustments were made in yields.

Measures were taken wherever possible of the topsoil in adjacent virgin areas at each location to serve as indices of the original depth of topsoil. The measurements made of these areas showed that the depth of topsoil in the areas considered did not vary widely and indicated that variations in depth of topsoil had been caused largely by erosion.

Each cultivated field was found to have developed its own erosion pattern. Some parts of the field had lost little soil while others had lost practically all of the original topsoil.

Corn yields for various soil depths were compared within the same field and between fields and also for the same depths at different locations. Because past management of these fields had varied, the yield levels of equal depths for fields under widely different management served as a good measure of the effect of conservation practices on corn yields as well as on erosion losses.

YIELDS ON SHELBY AND GRUNDY SOILS NEAR BETHANY, MO.[4]

The data secured at the Bethany experimental farm over a period of 7 years showed that a 4-year rotation on untreated soil from which about one-half the topsoil had been lost yielded more than four times as much grain as untreated subsoil. The yield of all forage exclusive of grain was 2.04 times that from the subsoil.

On another plot from which one-half the topsoil had been lost, a 3-year rotation of corn, oats, and clover and timothy was used. Lime was added at the rate of 3 tons per acre in the beginning and a superphosphate at the rate of 200 pounds per acre before the oats. The eroded surface soil yielded 1.8 times as much grain and 1.27 times as much forage as subsoil which received the same treatment.

On another plot where only one-half the surface soil remained, treated with fertilizer supplemented by 8 tons of manure and red clover stubble turned under, the corn-grain yield was 1.82 times the yield recorded for a subsoil area which received the same fertilizer and manure treatment supplemented by sweetclover turned under. The forage produced on the eroded surface soil was 1.6 times that produced on the subsoil area.

---

[4] The surveys were made and the yields taken on the Bethany project through the cooperative effort of the regional, area, project, and research personnel of S. C. S. A State W. P. A. project gave assistance in carrying forward this Federal and State project.

Grain yields on plots of eroded surface soil (measuring from 5 to 8 inches of topsoil) under complete conservation farming[5] was 3.23 times the yield from adjacent untreated areas. The forage from the treated areas was but 1.15 times as great.

The grain yield from subsoil receiving lime, fertilizer, and manure supplemented by sweetclover turned under was 7.27 times as great as where no treatment was applied. The yield of forage actually produced was 2.27 times as great from the treated area.

Summary data showing the relationship between the yield of corn and the depth of topsoil, together with the percent of the field area represented by each depth class for 1939 and 1940, are shown in tables 1 and 2, page 6. It will be noted that a large percent of the field areas at Bethany fell in the shallow depths and had correspondingly low yields, thus lowering the average yield of the entire area to 28.3 bushels per acre. For the fields harvested in 1940 the area represented by the shallow depths was somewhat higher than in 1939. The average production for all fields was 43.4 bushels per acre.

An interesting comparison can be drawn between fields 2 and 7 shown in table 3,page 7. These fields, comparable in length and degree of slope, were both broken out of sod about 65 years ago. Since that time field 7 has produced an equal number of crops of corn, small grain, and hay or grass. In the early cropping of this field corn was grown for four or more years, followed by several crops of small grain and finally by several crops of hay before corn again occupied the land. This system of cropping caused the field to erode badly. The survey showed that an average of 4.7 inches of topsoil had been washed off the field, and an average of 7.3 inches of surface soil was left.

In 1935, however, a complete conservation program was adopted for this field. Three tons of lime per acre were applied in the fall of 1934. Before each small grain crop, 200 pounds of superphosphate were applied. Preceding each corn crop, which followed clover stubble, 8 tons of barnyard manure were applied. In addition, all farming was done on the contour.

The average corn yield for this field in 1940 (5 years after starting soil conservation farming) was 70.5 bushels per acre. The corn yield decreased from locations with less topsoil to a minimum of 35 bushels per acre from those that had lost practically all topsoil. Locations with the deepest surface soils (11 inches or more) did not always produce the greatest yield, but many of these contained depoisted subsoil material. In these cases, lower yields were produced than in locations where the topsoil was 9 to 10 inches deep. This indicates that erosion may also decrease yield because of deposition of subsoil material on fertile topsoil.

For field 2 the past system of management, which before 1935 varied but little from field 7, was continued; no fertilizer, lime, or manure was applied. The corn crop in 1940 followed corn in 1939 and cultivation was up and down the slope.

---

[5] The conservation measures required to protect land against erosion and excessive runoff and insure satisfactory yields vary for the different sections of the country. In addition each farm and field presents varied problems which frequently call for a number of conservation measures. To be under a complete conservation program, each field must be used in accordance with the needs and adaptabilities of the land. These supporting practices necessary to insure the retention of topsoil with its large store of organic matter must be applied to insure satisfactory production over a continuous period.

TABLE 1.--*Corn yields from different depths of topsoil on four fields at Bethany, Mo., 1939*

Depth—Inches	Field area Percent of field	Yield Bushels per acre
13	1.0	47.3
12	2.0	45.1
11	3.0	43.0
10	7.2	40.4
9	7.0	37.3
8	14.0	33.4
7	12.3	30.3
6	11.5	28.2
5	11.0	25.1
4	12.0	21.0
3	19.0	17.1
Average 6.3	Total 100.0	28.3

TABLE 2.--*Corn yields from different depths of topsoil on seven fields at Bethany, Mo., 1940*

Depth--Inches	Field area Percent of field	Yield Bushels per acre
13+	1.2	67.5
11 - 12	3.2	57.8
9 - 10	9.9	55.4
7 - 8	28.5	50.4
5 - 6	32.3	43.7
3 - 4	17.2	35.4
1 - 2	6.7	24.9
0	1.0	15.2
Average 5.9	Total 100.0	43.4

TABLE 3.--*Yield of corn for different slopes and depths of topsoil, and the percentage of maximum yield*[1] *produced by each depth class, Bethany, Mo., 1940*

Number	Slope	Depth of topsoil													
		11" - 12"		9" - 10"		7" - 8"		5" - 6"		3" - 4"		1" - 2"		0"	
		Bu/A	%	Bu/A	%	Bu/A	%	Bu/A	%	Bu/A	%	Bu/A	%	Bu/A	%
1	5.9	49.8	100	43.1	87	37.0	74	30.5	61	30.1	60	14.9	30	9.0	19
2	7.5	51.4	100	43.2	84	41.9	82	38.2	74	27.2	52	21.7	42	16.2	32
3	6.0	51.8	100	44.6	86	41.4	80	38.3	74	23.9	46	16.6	32	9.0	17
4	4.2	54.1	100	48.2	89	44.3	82	40.9	76	31.3	58	16.0	30	5.2	10
5	2.9	54.9	100	48.3	88	44.8	82	37.2	68	32.6	59	21.9	40	11.2	20
6	7.9	66.4	84	76.4	100	64.4	84	55.4	73	44.0	58	32.3	42	20.6	27
7	7.2	76.0	91	84.0	100	78.7	94	65.3	78	58.7	70	50.7	60	35.0	42
Average	5.9	57.8	96	55.4	91	50.4	83	43.7	72	35.4	58	24.9	40	15.2	24

---

[1] The highest yield for any depth class for each field is listed as 100 percent. The marked variations in yields recorded for the same depth classes for the different fields are to a large extent due to differences in both past and present management. Some of the 11''-12''depth for fields 6 and 7 consisted of deposition of mixed topsoil and subsoil.

Large quantities of topsoil were washed from this field following heavy rains. The survey showed but 5.5 inches of topsoil remaining, which indicates an average loss of 6.5 inches of topsoil. The yield for those locations from which all topsoil had been lost was but 16.3 bushels per acre, whereas the average yield for the field was 32.6 bushels. There was but 4 percent of the acreage which had as much as 8 inches of topsoil remaining. It is recognized, of course, that these fields were not perfect checks, but it will be noted that the practice of complete conservation farming on field 7 since 1935 had checked the loss of topsoil and greatly increased the corn yields. It is significant that the average yield of this field was actually 2.17 times as great as on field 2 where conservation farming was not practiced. Observations made on these and other fields over a period of years showed that the yields of small grain and meadow were affected similarly.

Although the adoption of conservation farming can be expected to increase returns markedly, it must be remembered that yields from eroded fields are much lower than those from fields that are not eroded. Since conservation practices cannot entirely compensate for the accumulated loss of soil and organic matter over a long period of time, emphasis must be placed on the urgent need for the adoption of a conservation type of farming while a good amount of topsoil and organic matter remain.

The rapid reduction of organic matter and nitrogen resulting from a clean-tilled crop system of farming is shown by tables 4 and 5, page 10. These reductions occur very rapidly when the clean-tilled crops are not alternated with hay, including sod legumes, and when soil and water conservation measures are not used. Even the grassland that was overgrazed (field 2, table 5) lost a substantial amount of topsoil and organic matter.

The data show that the nitrogen in field 3, which had not been cultivated for 52 years, was well restored in the upper 6 inches after a half-century of grass, but that in the 0- to 21-inch layer it was considerably less than in fields 1 and 2, which had never been cultivated.

Field 4 (a cultivated field) averaged but 4.8 inches of topsoil. The percent of nitrogen in the 0- to 3-inch layer of soil was comparable to that in the 9- to 12-inch layer of field 1, which had never been plowed. The physical condition of the soil of this cultivated field was very poor, thus providing poor infiltration and allowing heavy runoff. The infiltration on fields 1, 2, and 3 was high and runoff was correspondingly low. Profile studies by the author and E. S. Vanatta in 1943 showed that 18 to 21 inches of soil had actually been eroded from field 4 and that there was little or no erosion on field 2.

YIELDS ON BROOKSTON, PARR, FOWLER, CROSBY, AND MIAMI SILT LOAM SOILS NEAR FOWLER, IND.[6]

The studies were carried out at Fowler, Ind., in 1939 and 1940 in the same manner as at Bethany, Mo., except that more fields were sampled. Summary data for 16 fields sampled in 1939 and for 18 fields sampled in 1940 are shown in tables 6 and 7, page 11. There was a marked decrease for both years in the yields of corn in those areas where the topsoil was shallowest.

These findings are similar to those obtained on the Shelby and Grundy soils near Bethany, Mo. The average range in corn yields in 1939 was from 49.2 bushels per acre for the locations that had but 1 to 2 inches of topsoil remaining to 93.4 bushels per acre for those having 13 or more inches of topsoil.

---

[6] The survey and yield data on the Fowler project were secured by the cooperative efforts of the regional, area, and project personnel of the Soil Conservation Service.

There was a difference of 44.2 bushels in the yields from locations having 13 or more inches as compared with those having depths of 1 to 2 inches. This is a reduction of 47.3 percent in yields. The extent of the areas represented by each depth class is shown in table 6, page 11.

Table 7, page 11, shows that for 1940 the corn yield ranged from 19.8 bushels per acre where little or no topsoil remained to 69.5 bushels where 13 or more inches of topsoil were left. This is a decline of 49.7 bushels or 71.5 percent. In other words in 1939 the deepest soil yielded 1.89 times as much as the shallowest soil. In 1940 the yield of corn on these areas where the soil was 13 or more inches deep was 3.51 times as great as on the areas where only 1 to 2 inches of topsoil remained.

Since the soil types are recorded for all fields harvested in 1939, an analysis was made of the yield data for each of the 3 important soil types that were mapped in each of 16 fields. These data, which are presented in table 8, page 11, show that for comparable depths the corn yields for the 3 soil types found in these fields did not vary widely. That each soil type was well represented is indicated by the fact that of the 1,183 areas sampled, 341 were Brookston silt loam, 476 Fowler silt loam, and 367 Parr silt loam.

Table 9, page 12, shows the corn yields for each of the 16 fields in the Fowler area for 1939. The average depth of topsoil for these fields ranged from 6.7 inches for field 8 to 11.7 inches for field 2. Here again it will be noted that while there is a definite relationship between soil depth and yield, there are also very striking differences in the yield levels of the different fields. A study of past cropping and management of these fields shows that the yields were much higher on fields where a conservation type of farming had been practiced. The yields where corn followed corn were almost always lower than where corn followed a legume sod.

The average corn yields for the different soil-depth classes are shown in table 10, page 13, for 19 fields harvested in 1940, together with the percent organic matter found in the plow depth of each of these fields. A statistical analysis was made of the data secured in 1939 and 1940. The analysis shows that there was a direct and highly significant correlation between the depth of topsoil and the corn yield, and that organic matter decreased markedly as the depth of topsoil was reduced by erosion.

The average percent of organic matter in the plow depth or top 7 inches is shown graphically in figure 3, page 14. It will be noted that the percent of organic matter decreases with depth of topsoil. The relationship between soil depth and yield as well as between organic matter and yield is shown graphically in figure 4, page 15. As shown by this graph, the amount of organic matter contained in the 0- to 20-inch layer of soil bears a close relationship with yields of corn from areas having varying amounts of topsoil.

YIELDS ON THE MARSHALL, SHELBY, AND TAMA SILT LOAM SOILS FOR TWO AREAS IN IOWA, AND ON THE KEENE, MUSKINGUM, AND COSHOCTON SILT LOAM SOILS IN OHIO

The corn yield data shown in table 11, page 17, were secured on 10 fields of Marshall silt loam at Shenandoah, Iowa, in 1939. The average slope of these fields was 8.5 percent and yields ranged from 119.9 bushels per acre where the depth was approximately 1 foot, to 52.3 bushels where but 1 to 2 inches of the topsoil remained. The studies indicated that the original depth of the topsoil in these fields averaged about 14 inches; whereas the

TABLE 4.--[1]*Percentage of nitrogen contained in soil profiles, by 3-inch layers, taken from four fields of Shelby silt loam at Bethany, Mo., under different types of management*

Soil depth, (inches)	Percent nitrogen			
	Field 1 Virgin bluestem pasture	Field 2 Virgin bluegrass pasture	Field 3 Bluegrass pasture since 1889	Field 4 Mostly cultivated crops since 1905
0 to 3	0.309	0.339	0.332	0.150
3 to 6	.216	.227	.210	.126
6 to 9	.182	.164	.163	.097
9 to 12	.146	.116	.125	.088
12 to 15	.121	.096	.098	.080
15 to 18	.097	.082	.075	.060
18 to 21	.075	.074	.066	.050

TABLE 5.--[1]*Calculated weight*[2] *of nitrogen per acre in soil profiles by 3-inch layers for fields shown in table 4*

Soil depth, (inches)	Pounds nitrogen--calculated			
	Field 1[3] Virgin bluestem pasture	Field 2[4] Virgin bluegrass pasture	Field 3[5] Bluegrass pasture since 1889	Field 4[6] Mostly cultivated crops since 1905
0 to 3	2,318	2,543	2,490	1,125
3 to 6	2,022	2,125	1,966	1,180
6 to 9	2,184	1,968	1,956	1,164
9 to 12	1,752	1,392	1,500	1,056
12 to 15	1,452	1,152	1,176	960
15 to 18	1,164	984	900	720
18 to 21	900	888	792	600
Total 0 to 21	11,791	11,051	10,780	6,805

[1] The nitrogen determinations were made under the direction of C. M. Woodruff, Soils Department, Missouri Agricultural Experiment Station, Columbia, Mo. The approximate percent of organic matter for these soils can be secured by multiplying the percent nitrogen by 17.

[2] Assumed 0 inches to 3 inches to weigh 750,000 lbs.; 3 to 6 inches 936,000 lbs.;and all depths below 6 inches 400,000 lbs. per acre-inch.

[3] Field 1 in virgin bluestem, never plowed, grazed moderately. Average depth of topsoil 13.0 inches.

[4] Field 2 in bluegrass pasture, never plowed, but pastured severely in spring of year, thus causing the bluestem to disappear and allowing some erosion. Average depth of topsoil 11.0 inches.

[5] Field 3 in bluegrass pasture since 1892. Before that several crops of corn were raised. Considerable erosion. Average depth of topsoil 8.7 inches.

[6] Field 4 handled same as field 3 before 1892. Since that time, cropped to corn for a number of years, followed by small grain and hay. From 1905 to 1909 in corn. Seeded to small grain and grass in 1910. Remained in hay until 1915. From 1915 to 1921 used as a feed lot--pastured from 1921 to 1928 when plowed up for corn. In corn or clean-tilled crops ever since (13 years). Average depth 4.8 inches.

TABLE 6.--*Corn yields from different depths of topsoil on 16 fields near Fowler, Ind., 1939*

Depth--Inches	Field area, percent	Yield, Bushels per acre
13+	9.3	93.4
11 to 12	13.2	88.6
9 to 10	17.3	82.3
7 to 8	22.7	73.4
5 to 6	20.7	66.7
3 to 4	12.9	58.3
1 to 2	3.9	49.2
Average 8.5		74.5

TABLE 7.--*Corn yields from different depths of topsoil on 18 fields at Fowler, Ind., 1940. (Average slope 3 percent)*

Depth--Inches	Field area, percent	Yield, Bushels per acre
13+	11.0	69.5
11 to 12	15.6	62.4
9 to 10	15.6	56.8
7 to 8	28.1	53.1
5 to 6	17.5	47.0
3 to 4	8.0	39.2
1 to 2	3.2	30.0
0	1.0	19.8
Average 8.3		54.6

TABLE 8.--*Corn yields for different depths of topsoil for three soil types at Fowler, Ind., 1939*

Soil depth, inches	Fowler silt loam, bu. per acre	Parr silt loam, bu. per acre	Brookston silt loam, bu. per acre	Average all samples, bu. per acre
13+	92.9	112.5	92.4	93.4
11 to 12	87.4	79.0	89.4	88.6
9 to 10	79.7	82.4	85.7	82.3
7 to 8	71.7	76.9	76.3	73.4
5 to 6	66.8	66.0	71.4	66.7
3 to 4	51.9	60.1	50.6	58.3
1 to 2		49.2		49.2

TABLE 9.--*Average yield of corn from different soil depths on 16 fields at Fowler, Ind., 1939*

Field Number	Depth of topsoil and bushels per acre							Average depth, Inches	Average depth, Bu. per acre
	13+	11" to 12"	9" to 10"	7" to 8"	5" to 6"	3" to 4"	0" to 2"		
1	66.6	72.2	68.0	58.7	59.8	54.4	31.3	8.6	61.2
2	113.3	89.8	81.6	76.8	70.7	59.8	35.4	11.7	84.3
3	87.1	88.4	74.8	78.9	80.2	71.7	51.7	8.4	77.5
4[1]	119.7	115.6	115.6	107.4	104.7	89.8	62.6	9.2	108.8
5[1]	114.2	106.1	109.8	102.0	90.2	70.7	51.7	8.0	95.2
6	112.2	104.9	97.1	98.6	95.2	87.7	62.1	7.9	96.6
7	78.9	85.7	85.7	68.0	66.6	61.2	51.7	8.0	72.1
8	95.2	92.5	89.8	83.1	81.6	72.2	54.0	6.7	77.0
9	74.8	68.8	66.1	53.9	49.4	47.6	38.0	8.1	57.1
10	80.0	71.4	61.5	57.5	53.5	53.2	34.0	8.3	58.5
11	77.5	78.9	77.5	73.9	62.3	44.9	35.4	8.1	69.9
12	84.9	80.0	62.7	56.6	52.6	44.9	32.0	7.2	55.8
13	90.4	82.3	62.0	51.7	45.8	39.4	34.0	8.1	55.8
14	60.3	85.4	87.6	74.8	68.0	52.1	43.0	8.8	76.2
15	89.6	83.0	72.8	70.3	59.2	53.0	40.0	8.0	68.0
16	94.1	83.5	84.3	68.8	53.7	51.0	48.9	9.5	76.2
Average	89.9	86.8	81.1	73.8	68.3	59.6	44.1	8.4	74.4

[1] Fields 4 and 5 were in bluegrass pasture for 20 years prior to 1938 but prior to 1918 had been cropped frequently to corn 4 or 5 years in succession. Management differences account for marked variations in yields for same depth classes for different fields.

TABLE 10.--*Corn yields from different depths of topsoil, together with the percent organic matter*[1] *in the plow depth (0 to 7 inches), Fowler, Ind., 1940*

Field Number	Depth of topsoil													
	13"+		11" to 12"		9" to 10"		7" to 8"		5" to 6"		3" to 4"		0" to 2"	
	Bu/A	% Org. Mat.	Bu/A	% Org. Mat.	Bu/A	% Org. Mat.	Bu/A	% Org. Mat.	Bu/A	% Org. Mat.	Bu/A	% Org. Mat.	Bu/A	% Org. Mat.
2 and 3	47.4	5.4	58.6	4.8	51.9	4.9	44.5	3.5	38.3	2.8	27.6	2.3	23.8	1.6
4 and 5	76.3	7.3	69.6	5.0	62.9	4.7	56.4	3.5	51.1	3.0	47.2	2.5	37.3	1.7
6 and 7[2]	90.6	4.3	90.5	3.8	81.6	4.0	67.4	3.7	59.1	3.4	57.8	2.7	44.9	1.9
8 and 9[2]	85.5	5.2	71.9	3.8	58.8	3.3	54.7	3.0	49.0	1.9	47.0	2.1	-	-
12, 13, 14, & 15	56.6	3.7	57.2	3.9	54.7	4.4	52.8	4.1	50.8	3.5	44.7	2.9	31.4	2.5
16 and 17	66.0	5.9	58.8	5.3	58.6	4.0	53.4	3.4	44.9	2.8	34.5	2.2	31.6	2.0
18	51.7	5.9	47.0	4.9	49.1	4.5	45.1	4.4	45.1	4.3	37.7	2.8	28.6	2.3
19, 20 and 21	75.4	5.2	57.1	4.3	54.8	3.8	44.7	3.5	38.2	2.8	28.2	2.4	17.7	2.2
22	74.9	3.6	65.6	3.7	61.7	2.9	53.5	2.5	50.2	2.2	46.0	2.2	37.4	1.5
Average	69.4	5.2	64.0	4.4	59.3	4.1	52.5	3.5	47.4	3.0	41.2	2.5	31.6	2.0

[1] The organic matter determinations were made by men furnished by the National Youth Administration, who worked under the direction of E. A. Carleton, Soil Conservation Service, in the Federal and State laboratory at Geneva, N. Y.

[2] Where the past management and field characteristics of two or more fields were the same, the fields were combined and treated as one. Fields 6 and 7 have had a 3-year rotation including use of sweetclover as pasture turned under before corn. Land has been limed and 8 tons of manure per acre returned every 4 years since 1926. Fields 8 and 9 have had a rotation including clover in effect since 1920 with some fertilizer used on the small grains. Here, as at Bethany, Mo., management was reflected in both depth of topsoil and yields.

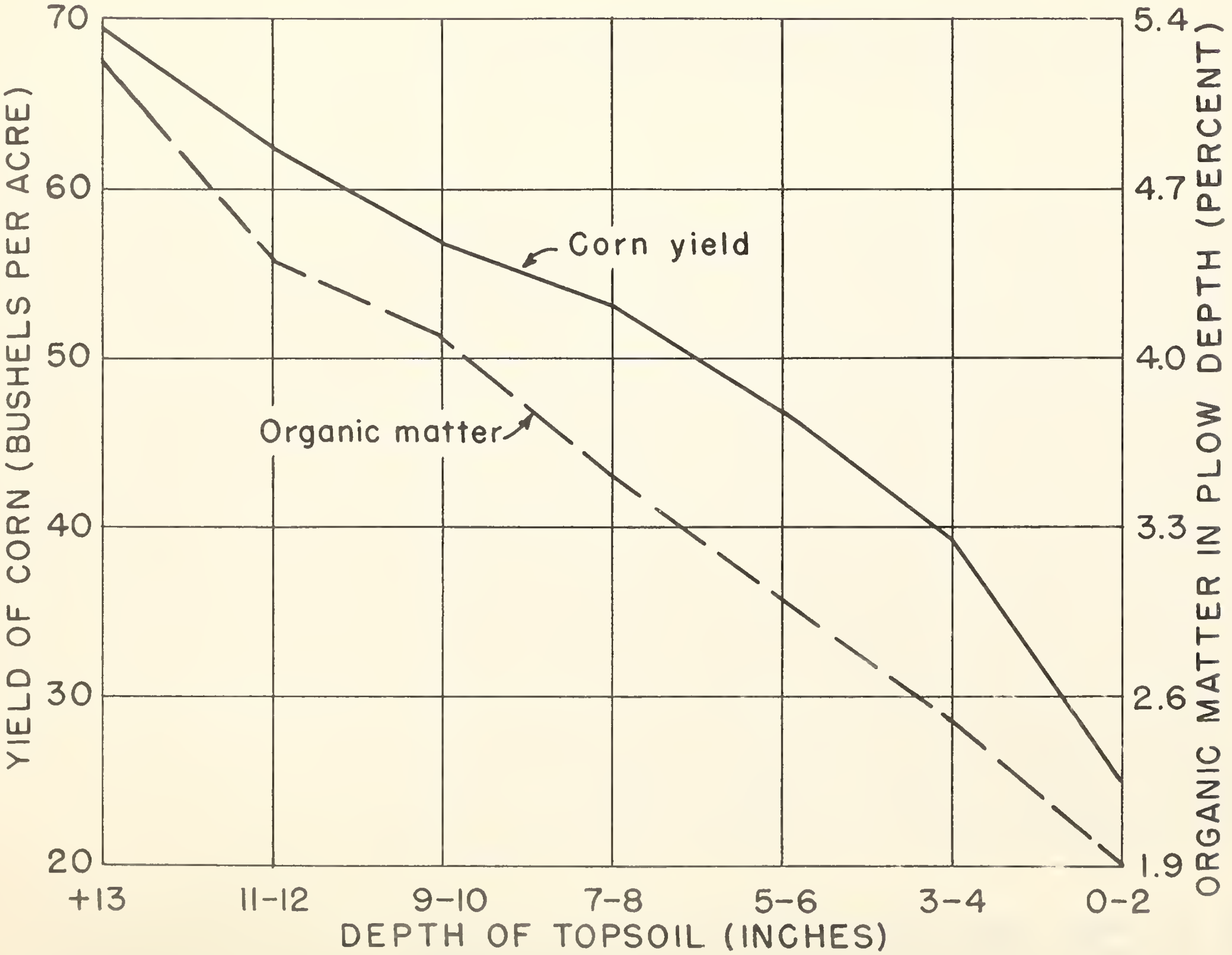

FIGURE 3.--Relationship of depth of topsoil and yield of corn, and the percent of organic matter in the plow depth or top 7 inches. Data from 19 fields, Fowler, Ind., 1940.

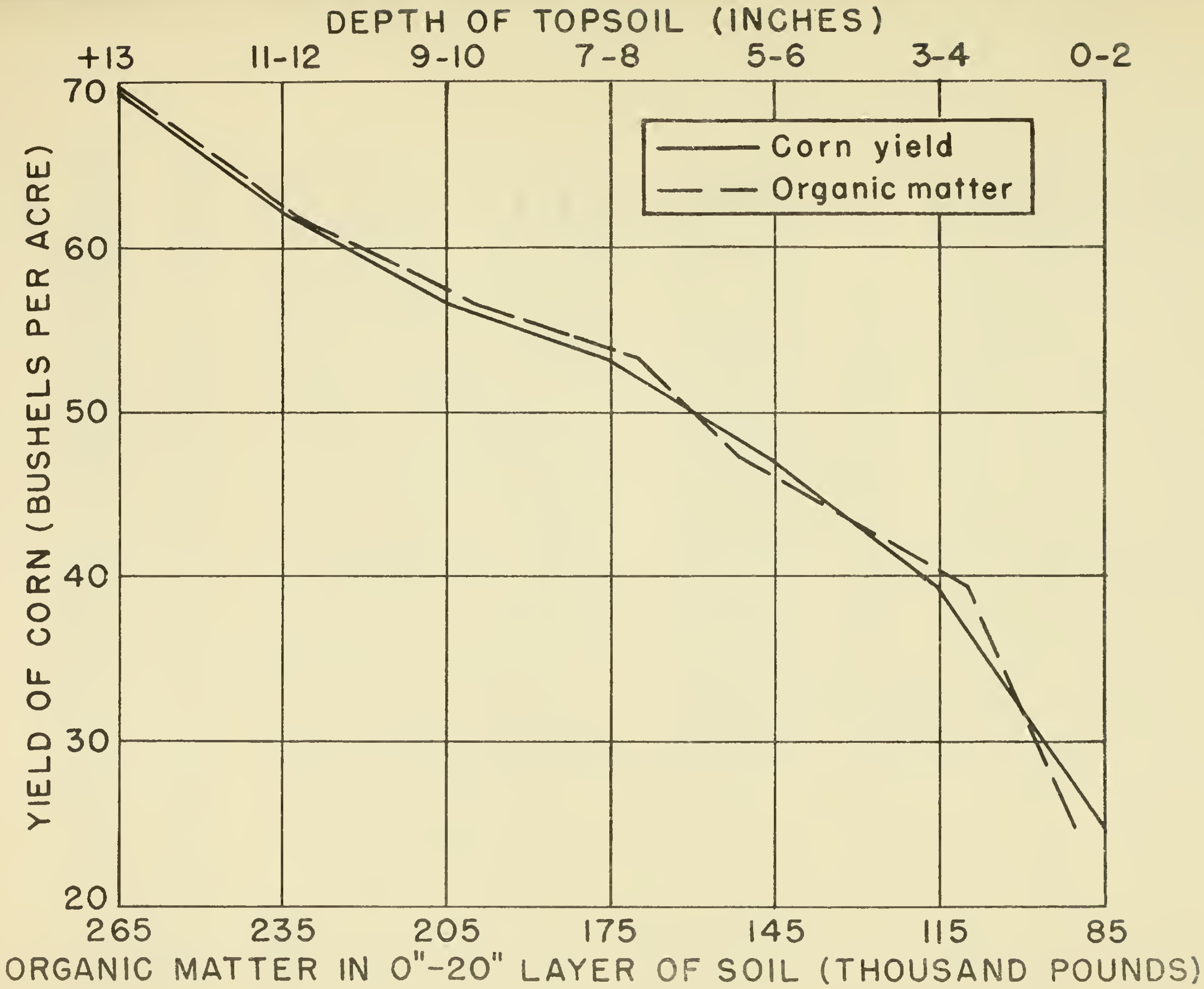

FIGURE 4.--Relationship between organic matter contained in the 0- to 20-inch layer of soil and corn yield, and association of corn yield with depth of topsoil. Data from 19 fields, Fowler, Ind., 1940.

present depth averages only 5.9 inches. It will be observed that 34.7 percent of the total area of these fields had less than 5 inches of topsoil remaining. Here again, it was found that the average depth of topsoil was greater and the corn yields higher where the past management of the fields had been best.

Table 12, page 17, shows the data from 38 fields near Greenfield, Iowa. The data on 21 fields of Tama silt loam showed an average yield of 63.9 bushels per acre where the topsoil measured about a foot, as compared with 31.8 bushels where the soil averaged $1\frac{1}{2}$ inches. On 17 fields of Shelby silt loam the yield from areas where little or no topsoil remained was but 24.7 bushels per acre as contrasted with a yield of 49.8 bushels per acre for areas where 7 to 8 inches of topsoil remained.

Corn yields were measured on three small watersheds at Coshocton, Ohio, in 1941 and the data are shown in table 13, page 18. The yield where 9 inches of topsoil remained was 59.5 bushels per acre as compared with 33.7 bushels where 4 inches of topsoil remained. This represents an actual reduction of 5.2 bushels per acre for each inch of soil below 9 inches. The yields for the depths between were 41.2 bushels for 5 inches, 46.4 bushels for 6 inches, 50.9 bushels for 7 inches, and 51.1 bushels for 8 inches. There was but 2.1 percent of the area of the watershed that had soil as deep as 9 inches; 50 percent of the total area had 6 inches or less of topsoil.

RESULTS ARE IN LINE WITH DATA REPORTED FOR OTHER AREAS AND FINDINGS OF STATE AGRICULTURAL EXPERIMENT STATIONS

Data presented in a U. S. Department of Agriculture booklet, "Better Harvests Through Conservation Farming,"[7] issued in March 1941, show that higher yields of cotton were secured at Spur, Tex., when the land was terraced and contoured. The results showed further that the yields of wheat and grain sorghums in the Southern Great Plains and the yield of beans in the Estancia Valley of New Mexico were markedly better when the land on which these crops were grown was terraced and contoured so that runoff was reduced and the topsoil held in place.

An evaluation survey report made in 1940 on the Winner-Dixon Project in South Dakota states that yields of small grains taken over a 3-year period comparing contour farming and non-contour farming show a 6 percent increase on the contoured areas. Their studies showed that in 1940 those areas with the deepest topsoil produced 90 percent greater yields than areas where most of the topsoil was gone. The difference for 1941 was 59 percent.

In 1948, results of a cooperative study are reported[8] by the Soil Conservation Service, the New Jersey Agricultural Experiment Station, and State Soil Conservation Committee, of the influence of topsoil depth on crop yields. Crop yields were measured during the period 1941-47 on a large number of privately owned farms in southern New Jersey. The results are summarized in table 14, page 18. Individual comparisons were made within the same fields on all eight crops. In every case the shallower topsoil gave lower per-acre yields.

---

[7] This booklet presents some of the results that have been obtained in recent years from practicing conservation farming. The data were secured in the Southern Great Plains and the Southwest.

[8] SOIL CONSERVATION SERVICE, NEW JERSEY AGRICULTURAL EXPERIMENT STATION, AND STATE SOIL CONSERVATION COMMITTEE. Soil Conservation Research in New Jersey. U. S. Dept. Agr. Soil Conserv. Serv., N. J. Agr. Expt Sta., and N. J. St. Soil Conserv. Com. 21 pp., illus. 1948. (Mimeographed.)

TABLE 11.--[1]*Corn yields from different depths of topsoil on 10 fields at Shenandoah, Iowa, 1939. (Average slope 8.5 percent)*

Depth--Inches	Field area, percent	Yield, Bushels per acre
11 to 12	6.3	119.9
9 to 10	9.6	109.0
7 to 8	18.0	92.7
5 to 6	31.4	79.6
3 to 4	26.0	65.4
1 to 2	8.7	52.3
Average 5.9		81.7

[1] Data on the Shenandoah, Iowa, project were secured through the cooperative effort of the area, project, and research personnel.

TABLE 12.--*Corn yields from different depths of topsoil for two soil types at Greenfield, Iowa, 1938*[1]

Depth, Inches	Tama Silt Loam		Depth Inches	Shelby Silt Loam	
	No. fields	Bu. per Acre		No. fields	Bu. per Acre
11 to 12	12	63.9			
9 to 10	9	58.1	7 to 8	4	49.8
7 to 8	8	45.8	5 to 6	8	45.2
5 to 6	14	42.8	3 to 4	15	38.9
3 to 4	10	38.4	1 to 2	10	35.1
0 to 2	9	31.8	0	14	24.7

[1] The data for the Greenfield, Iowa, project were taken by the project staff of the Soil Conservation Service.

TABLE 13.--*Corn yields from different depths of topsoil on three watersheds at Coshocton, Ohio, 1941*[1]

Depth—Inches	Field area, percent	Yield, Bushels per Acre
9	2.1	59.5
8	26.1	51.1
7	21.8	50.9
6	21.8	46.4
5	20.3	41.2
4	7.9	33.7
Average 6.4		46.7

[1] The data for Coshocton, Ohio, were furnished by the research staff on the hydrologic experiment station of Soil Conservation Service.

TABLE 14.--*Influence of depth of topsoil on crop yields on a number of New Jersey farms*

Crop	Yield Per Acre	
	More than 6 inches	Less than 6 inches
Potatoes	298 bushels	233 bushels
Corn	64 "	40 "
Wheat	34 "	17 "
Oats	32 "	21 "
Soybeans	18 "	4 "
Barley	55 "	26 "
Rye	37 "	11 "
Alfalfa	3.3 tons	2.0 tons

In O. R. Neal's annual report for 1948[9] he showed wheat yields from eroded areas in 1948 averaged 25 bushels per acre--as contrasted with 46 bushels per acre from uneroded areas. Differences in potato yields were even greater. Eroded areas averaged 124 bushels, while on uneroded areas in the same fields the yield averaged 383 bushels per acre. The value of conservation for the maintenance of soil productivity is obvious.

The author assisted in taking grape yields near Penn Yan, N. Y., in 1942 which were from two to four times as great from areas where the soil was 7 to 8 inches deep as from areas where only a trace of topsoil remained.

The same year, studies made on the production of roses near Newark, N. Y., showed that very inferior quality roses were produced on the severely eroded portions of the field. High quality roses were produced in large numbers on only those areas where eight or more inches of topsoil remained.

D. D. Smith,[10] reporting in 1943 on the effect of soil depth on the height of soybeans, stated that the height in all fields increased with increasing depth of the topsoil. The height of Virginia soybean stalks averaged 11 inches where most of the topsoil had been eroded away, as contrasted with an average height of 46 inches for areas where 12 inches of topsoil remained. For the Illini soybean the range was from about 13 inches on zero soil depth to 34 inches where the topsoil was a foot in depth. The grain yield was also related to the depth of topsoil.

At La Crosse, Wis., cooperative studies by the Soil Conservation Service and the State experiment station show that plots with only 3 inches of topsoil lost 45 percent more soil and water than plots with 6 inches of topsoil. The latter plots produced 29 bushels more corn per acre, 9 bushels more small grain, and 0.3 ton more hay than the plots that had only 3 inches of topsoil. These yields were secured during the period 1940-42 where a 5-year rotation of corn, small grain, and 3 years of alfalfa-brome was used on all plots.

The Ohio Agricultural Experiment Station[11] initiated a study in 1936 near Wooster to determine the relative crop production of topsoil and subsoil. Measurements were made of yield of corn, oats, wheat, and hay on virgin topsoil, double topsoil, and subsoil under different systems of cropping and management. Results for the first 9 years (1937-45) are shown in tables 15-18, pages 20-23.

It is obvious that the crop yields of this exposed subsoil, which had a favorable structure but was lacking in organic matter and other essentials for best crop growth, improved with treatment but they remained substantially lower than for the normal topsoil or the double topsoil, irrespective of treatment.

Further evidence of the lowered production on eroded soil or subsoil is shown in table 19, page 24. This shows the 1942 corn yields on soil renewal plots on the Bethany

---

[9] NEAL, O. R., and BRILL, G. D. Annual Report of Research in Methods of Soil and Water Conservation in New Jersey. U. S. Dept. Agr. Soil Conserv. Serv. 1948. (Typewritten, February, 1949.)

[10] SMITH, D. D. Soybeans and Soil Conservation. Mo. Agr. Expt. Sta. Bul. 469, 16 pp., illus 1943.

[11] UHLAND, R. E. Rotations in Conservation. U. S. Dept. Agr. Yearbook of Agr. 1943-47, Science in Farming, pp. 533-534, illus.; and supplementary unpublished data supplied in mimeographed form in 1947 by R. E. Yoder, chief, Dept. of Agronomy, Ohio Agr. Expt. Sta., Wooster, Ohio.

TABLE 15.--*Corn yields (bushels per acre) by years for virgin topsoil, double topsoil and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio (1937-45)*

Rotation No. and treatment[1]	Year	Double topsoil	Virgin topsoil	Subsoil (topsoil removed)
		Bushels	*Bushels*	*Bushels*
I. Corn-Corn-Wheat-Hay (No treatment)	1937	66.0	72.6	15.2
	1938	87.7	70.0	16.2
	1941	103.8	63.5	31.9
	1942	79.6	46.8	12.6
	1945	72.8	42.6	22.4
	5-yr. Ave.	82.0	59.1	19.7
II. Corn-Corn-Wheat-Hay (Lime to *pH* 6.5. Fertilizer 0-14-6)	1937	84.0	84.2	21.5
	1938	84.8	74.7	15.6
	1941	128.0	93.5	45.0
	1942	90.0	64.0	17.8
	1945	104.2	76.2	49.0
	5-yr. Ave.	98.1	78.5	29.8
III. Corn-Oats-Wheat-Hay (No treatment)	1937	72.2	76.8	13.0
	1941	112.5	66.5	31.3
	1945	86.0	49.4	26.4
	3-yr. Ave.	90.2	64.2	23.6
IV. Corn-Oats-Wheat-Hay (Lime to *pH* 6.5)	1937	64.2	74.3	11.4
	1941	111.6	64.0	27.7
	1945	77.0	50.0	37.6
	3-yr. Ave.	84.3	62.8	25.6
V. Corn-Oats-Wheat-Hay (Lime to *pH* 6.5. Fertilizer 0-14-6)	1937	79.4	83.3	21.5
	1941	119.2	82.9	43.6
	1945	95.8	74.8	57.6
	3-yr Ave.	98.1	80.3	40.9
VI. Corn-Oats-Wheat-Hay (Lime to *pH* 6.5. Fertilizer 0-14-6. Manure = 2/3 crop.)	1937	77.9	82.5	31.5
	1941	136.7	108.4	64.2
	1945	107.6	83.0	61.6
	3-yr. Ave.	107.7	91.3	52.4
VII. Corn-Wheat-Alfalfa-Alfalfa. (Lime to *pH* 7.0. Fertilizer 0-14-6)	1937	70.8	81.3	24.4
	1941	133.7	121.1	76.4
	1945	102.4	84.4	62.8
	3-yr. Ave.	102.3	95.6	54.5
VIII. Corn-Wheat-Alfalfa-Alfalfa. (Lime to *pH* 7.0. Fertilizer 0-14-6. Manure 1/3 crop)	1937	70.5	85.9	25.7
	1941	141.0	125.0	86.1
	1945	108.4	86.4	64.4
	3-yr. Ave.	106.6	97.1	58.7
IX. Corn-Oats-Alfalfa-Wheat & S. C. (Lime to *pH* 7.0. Fertilizer 0-14-6. Residues.)	1937	76.9	78.3	22.3
	1941	139.9	121.5	67.4
	1945	108.0	85.6	46.0
	3-yr. Ave.	108.3	95.1	45.2
X. Sweet Clover-Oats-Alfalfa-Wheat (Sweet Clover). Corn substituted for S.C. second rotation.[2] Fertilizer 0-14-6. Manure 6 tons + residues	1941	139.4	120.7	64.2
	1945	102.6	80.6	64.2
	2-yr. Ave.	121.0	100.7	64.2
XI. Sweet Clover and Orchard grass. Then same rotation and fertilizer as VII. (Lime to *pH* 7.0. Fertilizer 0-14-6. Manure - 6 tons.	1941	124.6	124.9	46.5
	1945	93.4	81.8	51.0
	2-yr. Ave.	109.0	103.3	48.8
	Ave. all rotations (35 crops)	98.65	81.82	39.31

---

[1] Fertilizer and manure were applied on corn and small grains each round of the rotation.

[2] Lime to *pH* 7.0.

TABLE 16.--*Wheat yields (bushels per acre), by years, for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45)*

Rotation No. and treatment *(See table 15)*	Year	Double topsoil	Virgin topsoil	Subsoil (topsoil removed)
		Bushels	*Bushels*	*Bushels*
I. C-C-W-H	1939	22.3	14.3	1.8
	1943	23.8	14.9	5.7
	2-yr. Ave.	23.1	14.6	3.8
II. C-C-W-H	1939	37.2	33.8	2.8
	1943	39.2	31.3	7.3
	2-yr. Ave.	38.2	32.6	5.1
III. C-O-W-H	1939	27.8	22.0	2.3
	1943	31.6	22.3	7.3
	2-yr. Ave.	29.7	22.2	4.8
IV. C-O-W-H	1939	25.0	19.8	5.7
	1943	21.8	12.8	6.5
	2-yr. Ave.	23.4	16.3	6.1
V. C-O-W-H	1939	34.7	33.8	7.7
	1943	42.2	31.3	11.5
	2-yr. Ave.	38.5	32.6	9.6
VI. C-O-W-H	1939	33.5	35.0	10.7
	1943	45.2	35.6	15.0
	2-yr. Ave.	39.4	35.3	12.9
VII. C-W-A-A	1938	47.3	31.8	4.0
	1942	22.8	26.8	16.0
	2-yr. Ave.	35.1	29.3	10.0
VIII. C-W-A-A	1938	45.5	41.1	14.0
	1942	21.0	28.8	27.0
	2-yr. Ave.	33.3	35.0	20.5
IX. C-O-A-W&S.C.	1940	34.7	38.1	36.2
	1944	Oats	Oats	Oats
X. C-O-A-W&S.C.	1940	31.8	36.6	31.3
	1944	Oats	Oats	Oats
XI. C-W-A-A	1942	25.6	30.0	13.8
Ave. all Rotations and Treatments (19 crops)		32.26	28.43	11.98

TABLE 17.--*Oat yields (bushels per acre) by years, for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45)*

Rotation No. and treatment *(See table 15)*	Year	Double topsoil	Virgin topsoil	Subsoil (topsoil removed)
		Bushels	*Bushels*	*Bushels*
III. C-O-W-H	1938	55.6	65.6	12.2
	1942	46.6	50.0	17.5
	2-yr. Ave.	51.1	57.8	19.9
IV. C-O-W-H	1938	46.3	60.9	8.8
	1942	59.1	52.8	13.1
	2-yr. Ave.	52.7	56.9	11.0
V. C-O-W-H	1938	65.0	63.1	7.5
	1942	55.9	55.3	24.4
	2-yr. Ave.	60.5	59.2	16.0
VI. C-O-W-H	1938	56.9	68.8	13.9
	1942	50.0	57.2	28.8
	2-yr. Ave.	53.5	63.0	21.4
IX. C-O-H-W&S.C.	1938	58.8	50.3	7.2
	1942	61.3	67.2	33.8
	2-yr. Ave.	60.1	58.8	20.5
X. C-O-A-O	1938	28.4	29.4	59.5
	1942	41.6	66.3	29.7
	2-yr. Ave.	35.0	48.9	44.6
Average all rotations and treatments (12 crops)		52.13	57.24	21.37

TABLE 18.--*Hay yields (tons per acre), by years, for virgin topsoil, double topsoil, and subsoil on Ohio Agricultural Experiment Station, Wooster, Ohio, (1937-45)*

Rotation No. and treatment *(See table 15)*	Year	Double topsoil	Virgin topsoil	Subsoil (topsoil removed)
		Tons	*Tons*	*Tons*
I. C-C-W-H	1940	4.54	2.84	1.56
	1944	1.86	1.11	.59
	2-yr. Ave.	3.20	1.98	1.08
II. C-C-W-H	1940	4.76	3.73	2.31
	1944	2.88	2.09	1.89
	2-yr. Ave.	3.82	2.91	2.10
III. C-O-W-H	1940	4.54	2.81	1.45
	1944	2.67	1.32	.85
	2-yr. Ave.	3.61	2.07	1.65
IV. C-O-W-H	1940	4.60	3.09	1.25
	1944	2.25	1.26	.75
	2-yr. Ave.	3.43	2.18	1.00
V. C-O-W-H	1940	4.74	3.08	2.24
	1944	2.27	1.62	1.63
	2-yr. Ave.	3.51	2.35	1.94
VI. C-O-W-H	1940	4.53	3.57	2.74
	1944	2.27	2.01	1.73
	2-yr. Ave.	3.40	2.79	2.29
VII. C-W-A-A	1939	3.29	1.99	1.81
	1940	4.75	3.67	3.38
	1943	3.91	2.55	2.15
	1944	2.82	1.99	1.66
	4-yr. Ave.	3.69	2.55	2.25
VIII. C-W-A-A	1939	4.11	2.88	2.42
	1940	4.73	4.10	3.56
	1943	4.48	3.70	3.51
	1944	3.24	2.59	2.17
	4-yr. Ave.	4.14	3.32	2.92
IX. C-O-A-W&S.C.	1939	3.87	2.13	1.79
	1943	4.24	3.26	2.27
	2-yr. Ave.	4.06	2.70	2.03
X. C-O-A-W	1939	3.20	1.83	.90
	1943	4.43	3.25	2.28
	2-yr. Ave.	3.82	2.54	1.59
XI. C-W-A-A	1944	2.83	2.42	1.54
Average all rotations and treatments (25 crops)		3.67	2.60	1.94

TABLE 19.--*Data on soil renewal plots at Bethany, Mo., Soil and Water Experiment Station*

Plot No.	Cropping system[1]	Treatment (2)	Corn yield 1942	Organic matter 1943	Total soil loss 1932-42	Water loss 1932-42
			Bu./acre	*Percent*	*Inches*	*Inches*
1	C-O-H-H	None	43.0	2.84	0.83	42.9
2	C-O-H-H	None	20.5	1.93	1.22	48.4
3	C-O-H-H	L + P	34.6	1.96	.53	29.7
4	C-O-Cl & T	L + P	32.2	1.89	.76	39.6
5	C-O-Sw.Cl.	L + P	44.0	2.00	.72	33.0
6	C-O-Sw.Cl.	L + P + M	64.6	2.26	.62	34.1
7	Grass-Legume Mixture	L + P	44.2	2.16	.007	12.1

[1] C = Corn; O = Oats; H = Hay; Cl & T = Clover & Timothy; Sw. Cl = Sweetclover. All plots except plot 1 were subsoil.

[2] L + P = Lime + Phosphate; L + P + M = Lime + Phosphate + Manure.

Soil and Water Conservation Experiment Station farm. This experiment was started in 1931 on an 8-percent slope and on plots 10½ feet wide and 80 feet long.

It will be noted that the corn yield on plot 2, which was untreated subsoil, was slightly less than 48 percent of the yield on plot 1, the moderately eroded and untreated topsoil. Practically the same percentage difference was measured for the oat and hay yields for the previous 10-year period. Plot 3, which was limed and cropped to the same 4-year rotation as plots 1 and 2 but received 200 pounds of superphosphate per acre, yielded 84 percent as much corn as the untreated topsoil (plot 1). The average corn yield for the three corn crops was 84 percent of the corn yields on the untreated topsoil. However, corn that was produced on similar topsoil that had been limed and fertilized yielded 96 bushels per acre in 1942. This was more than twice the yield of untreated topsoil and almost five times the yield of untreated subsoil.

The freshly exposed subsoil contained 1.71 percent organic matter in 1930. Where clean fallow without cropping was practiced for 13 years, 8.7 inches of rainfall was lost annually as runoff and the soil loss averaged 56.5 tons per acre per year, or 5.5 inches for the 13-year period. During this same period the organic matter decreased to 1.41 percent, a loss of 0.3 percent or about 3 tons of organic matter per acre.

The data on organic matter, as well as that on soil and water losses at Bethany, illustrate the exceedingly slow rate at which organic matter can be built up in soils. Where a 4-year rotation of corn-oats and 2 years of hay was used on plot 2 (untreated subsoil) 1.2 inches of soil was lost in 11 years by erosion but there was a small gain in organic matter.

On plot 7, lime and fertilizer were applied to the subsoil prior to seeding a grass and legume mixture in 1931. By allowing all crop growth to remain on the plot, the soil lost only 0.007 inch per acre during the 11-year period and the organic matter was raised to 2.16 percent, a gain of 0.45 percent or 4.5 tons per acre. Plot 1, the moderately eroded but untreated Shelby loam surface soil cropped to the same rotation, had its organic matter lowered from 3.02 percent in 1930 to 2.84 percent in 1942.

Eroded soils or exposed subsoils are usually more difficult to cultivate and allow more runoff, contain less plant food, and make less effective use of the rainfall for plant growth. Unless erosion and runoff are controlled, much of the plant food applied as fertilizer may be lost. It should be pointed out that the cultural operations on the soil renewal plots at Bethany were carefully performed and the runoff and soil losses were lower than might be experienced on badly eroded farm fields.

Long-time experiments for testing crop rotations and fertilizer and lime applications have been conducted by many State agricultural experiment stations. The results have been released in appropriate State publications. The marked differences in the production of different soil groups within the same State are illustrated in a recent report by Bauer[12] on 24 soil experimental fields in Illinois. This summary report shows graphically the relative returns secured from a livestock system of farming versus a grain system of farming on each of these fields. In addition, the effects of applying different fertilizer treatments to the soils at each of the locations and under the different systems of farming are shown. Among other things, the data show that it required from 600 to 700 acres of the poorer untreated land to yield the same returns as those that were secured on 100 acres of untreated good Corn-Belt land. When the needed treatments were added and proper management followed, slightly less than 200 acres of the lowest yielding land was required to give the same net return as 100 of the treated acres of the best producing areas.

---

[12] BAUER, F. G. The Comparative Effects of Soils, Fertilizers and Systems of Soil Treatment on Crop Yields. A mimeographed summary of soil experimental field results, 1910-1938. Univ. of Ill. College of Agr. Ext. Serv. in Agr. and Home Econ. Urbana, Ill. June 1939.

When land is used properly and needed supporting soil and water conservation practices are used, Nature is given time to compensate for the small amount of soil that is removed by erosion.

But where land is cultivated or left bare, and no protection provided, accelerated erosion takes place which may be a thousand times faster than when protected. In like manner, accelerated erosion may occur on pastures and woodlands that are overgrazed, burned, etc. The extensive data reported herein show that the loss of topsoil is reflected immediately in reduced yields.

WHAT FARMERS SAY ABOUT CONSERVATION AND YIELDS

In 1943, more than 9,300 farmers, who operated almost 4 million acres of land well distributed throughout the United States, reported on the benefits derived from soil and water conservation. Of the 9,300 farmers reporting, 96 percent said their crop yields had been increased as a direct result of soil conservation. They estimated that the average increase for all major crops grown throughout the country was 35.7 percent.

Those farmers who adopted soil and water conservation farming before they had lost too much topsoil are securing the highest per acre yields and have realized the greatest increases.

CONSERVATION FARMING MUST BE ADAPTED TO MEET THE NEEDS OF THE INDIVIDUAL FARM AND FARMER

Each farm and field presents varied problems which frequently call for a number of conservation measures. Figures 5 and 6, page 27, are examples of the many farms in the Corn Belt on which a completed soil and water conservation program has been adopted. This farm is being used in accordance with the needs and adaptabilities of the land in each field as well as the needs of the farmer. The supporting practices have been applied that are necessary to insure the retention of the topsoil with its large store of organic matter.

Extensive data secured through planned field studies, as well as the actual reported experiences of more than 9,300 farmers in the East, West, North, and South confirm the statement that the loss of topsoil causes a marked reduction in the per-acre yields of all the major crops. Reduction in crop yield is directly proportional to the loss of topsoil, and this reduction starts with the loss of the first inch of soil.

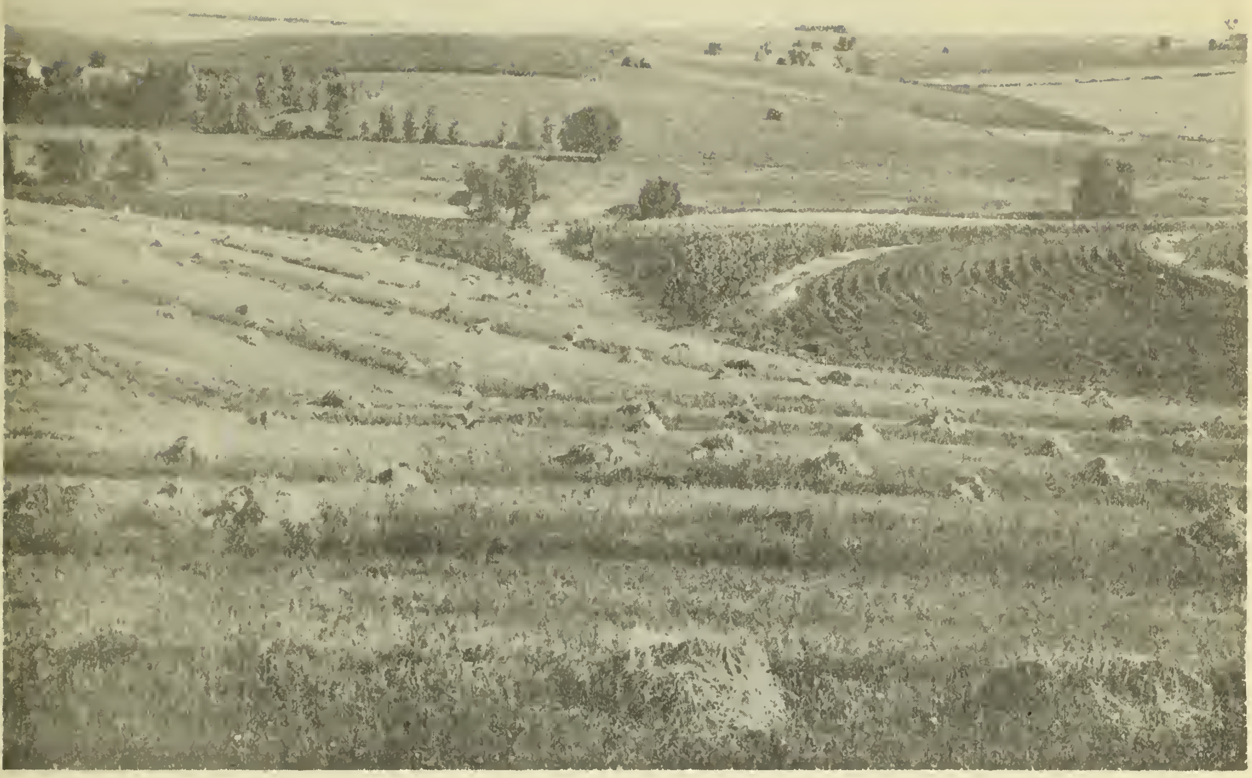

FIGURE 5.--Good crop rotations supported by terracing and contouring insure the conservation of the soil on this farm.

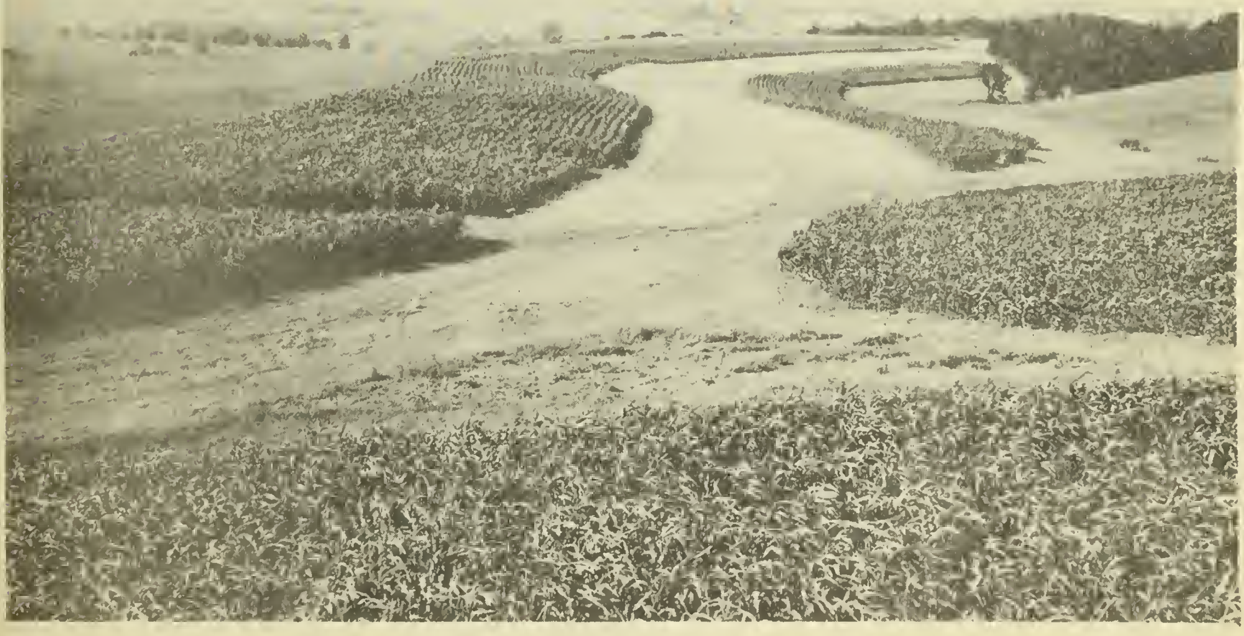

FIGURE 6.--Rotated contour strips supported by broad grassed waterways are proving effective in conserving soil and water on this dairy farm.

NATIONAL AGRICULTURAL LIBRARY
1022536375

NATIONAL AGRICULTURAL LIBRARY
1022536375